Comparison between spectroscopic ellipsometry and HRTEM-VEELS analyses of HfO_2-based stacks.

C. Guedj[a], C. Licitra[a], G. Auvert[b], G. Audoit[a], D. Lafond[a], E. Martinez[a], F. de la Peña[a], P. Bayle-Guillemaud[c], N. Gambacorti[a], A. Chabli[a], F. Bertin[a]

[a] CEA-LETI, MINATEC Campus, 17 rue des Martyrs - 38054 Grenoble Cedex 9, France
[b] STMicroelectronics, 850 rue Jean Monnet, 38926 Crolles, France
[c] CEA, INAC, 17, Rue des Martyrs, 38054 Grenoble, France

ABSTRACT

HfO2-based materials are interesting candidates for advanced CMOS gate dielectrics and for advanced devices such as non volatile memories. The downscaling trends driven by the industry induce drastic requirements in terms of nanocharacterization of the structural, optical and electronic properties. Among the various characterization tools for high-k materials, optical methods such as spectroscopic ellipsometry has been proved to be efficient for the determination of thicknesses and optical properties of thin films with nanometric resolution[1], however these methods are usually not applicable to a site-specific nm-area analysis of the dielectric characteristics of nanometric devices. One of the most prominent alternative is the valence electron loss spectroscopy (VEELS) inside a high-resolution transmission electron microscope[2]. This technique, combined with conventional EELS, may provide interband transitions energies (bandgap), plasmons frequencies, and chemical composition analysis with nanometric spatial resolution[3]. In this presentation, we will compare the results obtained by spectroscopic ellipsometry and HRTEM-VEELS on the same sample. We will demonstrate that a good agreement is obtained between the two methods for the bandgap, the optical indexes and the layer thicknesses.

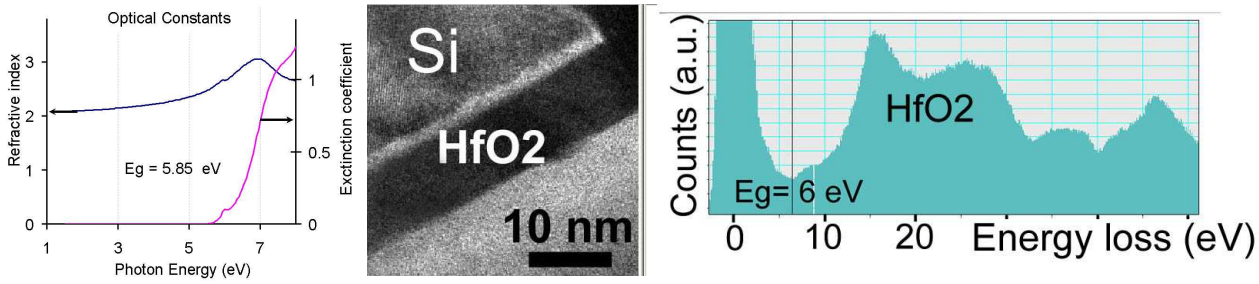

FIGURE 1 : Optical indexes obtained by spectroscopic ellipsometry (left), for a 10 nm thick HfO2 stack (center). The bandgap of 6 eVobtained by HRTEM-VEELS (right) is very close to the value obtained by ellipsometry (5.85 eV).

REFERENCES

1 F. Ferrieu, K. Dabertrand, S. Lhostis, V. Ivanova, E. Martinez, C. Licitra and G. Rolland., J. Non-Cryst. Sol. , Vol. 353, Issue 5-7, p 658 (2007)
[2] M.C. Cheynet, S. Pokrant, F.D. Tichelaar, J-L. Rouviere, J. Appl. Phys. 101, 054101 (2007)
[3] R. F. Egerton, Electron Energy Loss Spectroscopy in the Electron Microscope Plenum, New York, 1996